

True fishes—Continued.

The bony fishes—Continued.

The silver hakes and cods—Continued.

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INTRODUCTION

In the summer of 1912 the Bureau of Fisheries, with the cooperation of the Museum of Comparative Zoology of Harvard University, undertook an oceanographic and biological survey of the Gulf of Maine, with special reference to its fishes and floating plants and animals (plankton), its physical and chemical state, and the circulation of its waters. Subsequent cruises were made on the fisheries schooner *Grampus* during the summers and autumns of 1913, 1914, 1915, and 1916, and during the winters and springs of 1913 and 1915. The work was interrupted by the war, but was resumed with a cruise of the fisheries steamer *Albatross* in the late winter and spring of 1920 and continued by the fisheries steamer *Halcyon* during the winter and spring of 1920-21 and the summers of 1921 and 1922. Several reports on special phases of the survey have been published, but not until 1920 did the body of data warrant undertaking a general account of the fish fauna, general biology, and oceanography of the Gulf, of which the present memoir is the first part.

In the division of labor the preparation of the section on the fishes was assigned to my coworker, W. W. Welsh, who had given special attention to this phase of the work throughout all the years of the survey, both on the regular oceanographic cruises and on many trips on commercial fishing vessels, in the course of which he

had gathered a large body of original observations on the growth, reproduction, diet, and other phases of the lives of many of the more important species. The report was far advanced when interrupted by his untimely death, and so much of the material had been collected that, at the request of the Bureau of Fisheries, I have undertaken to carry it to publication along the lines originally laid down, though I am unable to give it the value it would have possessed had Mr. Welsh been able to finish it.

SCOPE OF THE WORK

Our aim has been to prepare a handbook for the ready identification of the fishes occurring in the Gulf of Maine, and to present a concise statement of what is known of the distribution, relative abundance, and the more significant facts in the life history of each. The descriptions have been made as little technical as is compatible with scientific accuracy, and are chiefly limited to such external features as may suffice for identification in the field. As a further aid to identification, keys to all species have been provided. In every case the sizes of larval fish or eggs have been given in millimeters (1 inch equals 25.4 millimeters), but these can be easily converted into inches or parts of an inch. We have followed Garman (1913) in the nomenclature of the sharks, skates, and rays, and Jordan and Evermann (1896-1900) for all the others, except as noted. For each species we have given page references to these authors, where the reader, if interested, may find more detailed descriptions and synonymies. Most of the illustrations have been borrowed from earlier publications, but a few are original. Rules given under illustrations represent a length of 1 inch.

AREA COVERED

The term "Gulf of Maine" covers the oceanic bight from Nantucket and Cape Cod on the west to Cape Sable on the east, thus including the shore lines of northern Massachusetts, New Hampshire, Maine, and parts of New Brunswick and Nova Scotia. The eastern and western boundaries adopted in this paper are 65° and 70° west longitude, respectively. Southern species, recorded but once from Nantucket and which have no real status in the Gulf of Maine except as accidental stragglers, have been relegated to footnotes. The Gulf of Maine has a natural seaward rim formed by Nantucket Shoals, Georges Bank, and Browns Bank. We have chosen the 150-fathom contour as the arbitrary offshore boundary because this will include all the species likely to be caught by commercial fishermen and will exclude almost the entire category of deep-sea fishes so numerous in the basin of the open Atlantic but not constituents of the fauna of the Gulf of Maine.

The general geography of this area will be the subject of another report, but it may not be amiss to point out here that the temperature of the Gulf and its fauna as a whole are boreal, its southern and western boundaries being the northern limit of common occurrence of many southern species of fishes and invertebrates.

SOURCES OF INFORMATION

The literature dealing with the fishes of the Gulf of Maine begins with the earliest descriptions of New England, for the fishery possibilities of the Gulf so impressed the early voyagers, even prior to the first settlement, that almost all accounts of their travels contain first-hand observations on the local abundance of fish of one species or another. Capt. John Smith (1616), for instance, commented on the abundance of sturgeon, cod, hake, haddock, cole (the American pollock), cusk, sharks, mackerel, herring, cunners, eels, salmon, and bass in 1616, while Wood (1634), in his "New England's Prospect," gives much interesting information, some of which is quoted hereafter. It was not until the early part of the nineteenth century that the sea fishes of northern New England and of the Maritime Provinces began to attract scientific attention, but since then the local faunal lists for that region have become numerous. The following, in chronological order, are the most important of these:

1850.—"Report on the sea and river fisheries of New Brunswick, within the Gulf of St. Lawrence and Bay of Chaleur," by M. H. Perley. 137 pp., 1850. Fredericton.

1853-1867.—"A history of the fishes of Massachusetts," by David Humphreys Storer. *Memoirs, American Academy of Arts and Sciences, New Series*, Vol. V, pp. 49-92, 122-168, and 257-296; Vol. VI, pp. 309-372; Vol. VIII, pp. 389-439; Vol. IX, pp. 217-256, 39 pls. (Also in book form with supplement.) Cambridge and Boston.

1879.—"A list of the fishes of Essex County, including those of Massachusetts Bay, according to the latest results of the work of the U. S. Fish Commission," by George Brown Goode and Tarleton H. Bean. *Bulletin, Essex Institute*, Vol. XI, No. 1, pp. 1-38. Salem.

1884.—"Natural history of useful aquatic animals," by George Brown Goode and associates. Section I, *The Fisheries and Fishery Industries of the United States*, published jointly by the United States Fish Commission and the United States Bureau of the Census. Washington.

1908.—"Fauna of New England. 8. List of the Pisces," by William C. Kendall. *Occasional Papers, Boston Society of Natural History*, Vol. VII, No. 8, April, 1908, pp. 1-152. Boston.

1914.—"An annotated catalogue of the fishes of Maine," by William C. Kendall. *Proceedings, Portland Society of Natural History*, Vol. III, 1914, Part 1, pp. 1-198. Portland.

1922.—"The fishes of the Bay of Fundy," by A. G. Huntsman. *Contributions to Canadian Biology*, 1921 (1922), No. 3, pp. 1-24. Ottawa.

Either at first hand or by reference to the original sources these faunal lists contain all the published locality records of the rarer species, while the last two, with a paper by Gill (1905b), give complete ichthyological bibliographies respectively for the coasts of Maine, New Brunswick and Nova Scotia, and Massachusetts. A similar list of the captures of deep-water forms along the outer part of the Continental Shelf is contained in Goode and Bean's "Oceanic Ichthyology" (1896).

The most pertinent extralimital lists are Smith's (1898) and Sumner, Osburn, and Cole's (1913) lists of Woods Hole fishes for the waters immediately to the west, and Halket's (1913) check list of the fishes of Canada for those to the east and north of the Gulf of Maine. With these readily available we have not thought it worth while to burden the present paper with the authorities for localities except in the more interesting cases. To save constant repetition we state here that almost all of the information as to the Bay of Fundy given hereafter is drawn either from Huntsman's paper or from his unpublished notes. Much information as to local

distribution and relative abundance has been gleaned from the fishery statistics published by the United States Bureau of Fisheries, the Dominion of Canada, and the Commonwealth of Massachusetts.

The literature dealing with the lives and habits of fishes occurring in the Gulf of Maine is very extensive, for most of the important commercial species, and many of the others, are common to both sides of the North Atlantic and have come within the scope of the intensive studies carried out of late years by European zoologists in conjunction with the International Committee for the Exploration of the Sea, while considerable attention has been devoted to them by American ichthyologists, also (published for the most part by the United States Bureau of Fisheries). The many scattered accounts of eggs and larvæ of northern fishes have been collected by Ehrenbaum¹ in his general summary of their developmental stages, a compilation the utility of which can hardly be overrated.

Among the other general European manuals, Day's "Fishes of Great Britain and Ireland"² and Smitt's "Scandinavian Fishes"³ are especially helpful. We have also had access to a great amount of unpublished material in the files of the Bureau of Fisheries, especially instructive being the schedules turned in by observers who accompanied certain otter trawlers during 1913, and the observations of Vinal Edwards on the diet of fishes at Woods Hole. The superintendents of the New England hatcheries have supplied much valuable information, as noted in the appropriate connections. Dr. A. G. Huntsman has, with great kindness, contributed his unpublished notes on the fishes of the Bay of Fundy and Gulf of St. Lawrence, allowing us to quote freely from them, while Prof. J. P. McMurrich has permitted the use of his unpublished plankton records. W. F. Clapp, formerly of the Museum of Comparative Zoology at Harvard University, has contributed many interesting notes gleaned during his experience as a fisherman before his entrance into the scientific field. Harry Piers, of the Provincial Museum of Halifax, has supplied interesting notes on the occurrence of the blue shark.

We owe a debt of gratitude, also, to Dr. Samuel Garman, who has ever been ready with assistance, and to W. C. Adams, director of the division of fisheries and game of the State of Massachusetts. Finally, we wish to express our thanks to the many commercial fishermen who have unfailingly met our inquiries in the most cordial way and who supplied Mr. Welsh with a vast amount of first-hand information on the habits, distribution, and abundance of the commercial fishes, which could be had from no other source. Without their help the preparation of this handbook would have been impossible.

¹ Eier und Larven von Fischen, by E. Ehrenbaum. Nordisches Plankton, Vol. I, 1905-1909 (1911), 413 pp., 148 figs. Kiel und Leipzig. (Appeared in two parts as Lief. 4, 1905, and Lief. 10, 1909.)

² The fishes of Great Britain and Ireland, by F. Day. Text and atlas, 1880. London and Edinburgh.

³ A history of Scandinavian fishes, by B. Fries, C. V. Ekstrom, and C. Sundervall. Second edition revised and completed by F. A. Smitt, 1892, 1,240 pp., 53 pls. Stockholm.